3rd Quarterly Report – Public Page

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Prepared for: *PHMSA-DOT, National Biodiesel Board, Steel tank Institute, DNV Research and Innovation*

Project Title: *Corrosion and Integrity Management of Biodiesel Pipelines*

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Technical Status

The third quarter has been devoted to organization of testing schedules and procurement of testing materials. A lot of effort was expended on allocating sources for biodiesel samples including persistent attempt at reaching The National Biodiesel Board yet to no avail. Some effort has also been expended in bringing on new team member here at DNV to handle the independent testing tasks.

The previous set of inhibitors that was to be tested based on discussions with a number of pipeline operators and literature review has been amended. The following products were previously suggested: Dupont AFA-1, Nalco EC 5407-A, and Tolad 3032. Upon contact with inhibitors producers and suppliers, it was discovered that Dupont AFA-1 is no longer being produced and that Tolad 3032 is actually a cold flow properties additive and not specifically a corrosion inhibitor. The executive decision to go with Tolad 3232, which is an active corrosion inhibitor, was made as a replacement. The Dupont product chosen to replace the AFA-1 is DCI-30.n, a caustic corrosion inhibitor designed for petrodiesel pipeline application. The Steel Tank Institute has supplied samples of CS 1018 comparable tank steel so that testing may closely follow immersion study outlined in NACE TM0172. These samples are being kept under desiccation until biodiesel samples are acquired.

It is still this project’s intention to test three different saturation levels of biodiesel to address the differing properties of ASTM D 6751 spec fuel. Currently, however, we may be limited by the feedstock made available to us by independent suppliers, outside of the NBB, willing to donate directly to DNV to aide in the progress of our testing program. The National Biodiesel Board has still not yet been able to provide fuel samples for this testing, so independent sources have been arranged.

Finally, for Task 4, the specific elastomeric materials were chosen based on polymer groups defined in the literature review: A fluoropolymer called Viton A-200, a nitrile rubber called Buna-N and Virgin PTFE. Suppliers have been identified for these products and they have been procured.

The basic construction of test setups has also been completed. We have three main setups that coordinate with the three technical tasks involved in the proposed work:

Task 1 – Corrosion Inhibition Performance
Task 2 – Integrity of Non-Ferrous Metallic System Components (Cu-alloys)
Task 3 – Integrity of Non-Metallic System Components (Elastomers)

The test setups for Tasks 2 and 3 are congruous and consist basically of a daisy chain of temperature controlled glass vessels each containing a distinct experiment based on the proposed matrices. Task 4 utilizes a specialized block furnace for the testing of elastomeric materials. The basic setup for each task is pictured in the following figures.

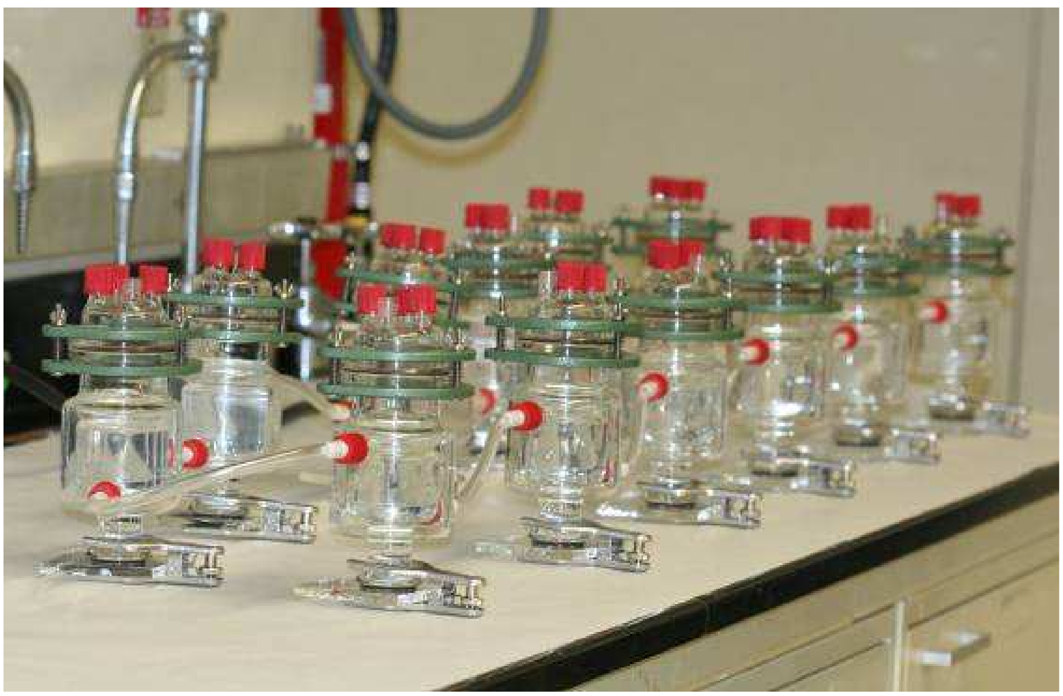

Figure 1. Array of test cells for inhibitors and Cu-alloys testing in biodiesel.

A close up of one of the glass cells in the area is pictured in the next figure.

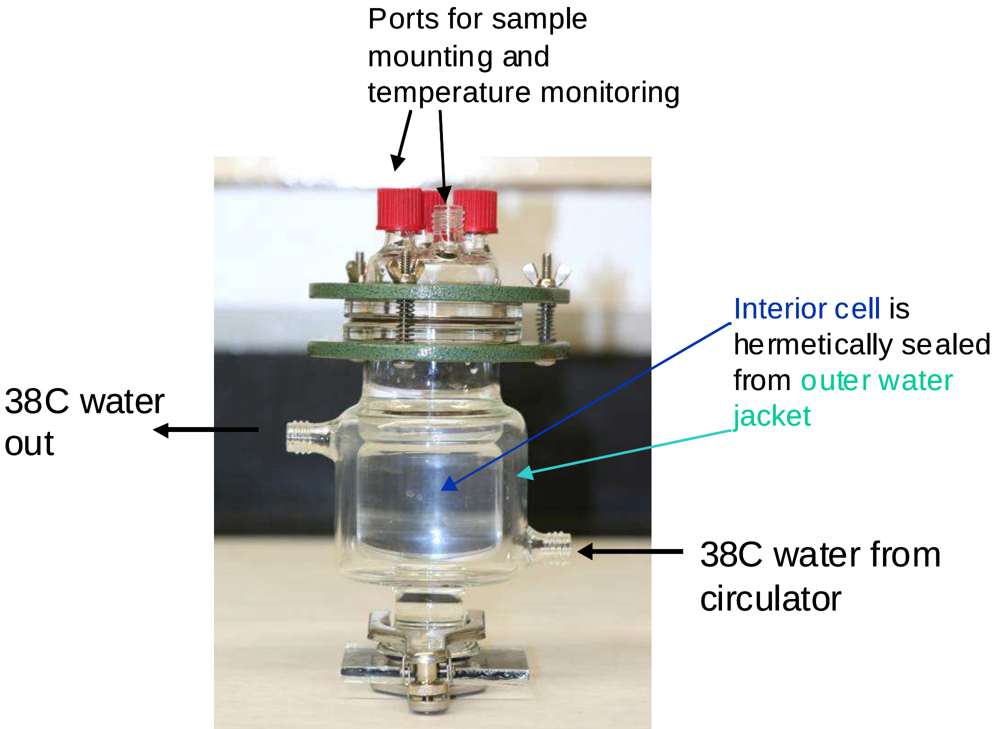

Figure 2. Example temperature controlled test cell to be used in immersion studies.

Each test cell will be daisy-chained to a circulating bath that will keep the immersions at 38 +/- 1°C. Preliminary tests have been conducted to ensure that the temperature drop from the first cell connected to the bath to the last in the array is maintained within +/- 1°C window. After a two hour period for equilibration of the system the temperature in cell 1 was 38.4 °C and the final cell (cell 12) was reading a temperature 37 °C. Fluctuation within the spread of cells was less than 0.5 °C from one to the next. Twelve cells will be allocated to the inhibitors testing. A similar setup of eight additional cells will be utilized for the Cu-alloy and fuel degradation studies.

The second portion of inhibitors testing will also begin as soon as biodiesel fuel samples are acquired. This will include sophisticated electrochemical measurement of the efficacy of the known corrosion inhibitors via the use of micro-electrode array testing.

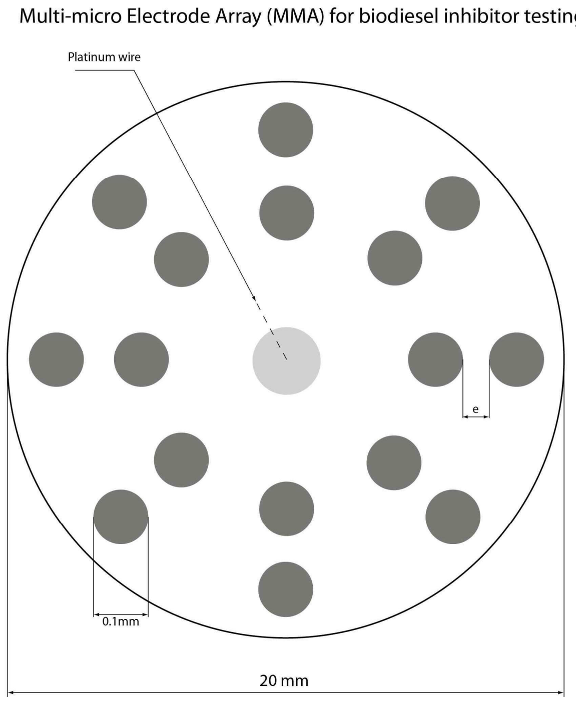

Figure 3. Schematic of the face of the multi-electrode array probe.

Task 2 – Integrity of Non-Ferrous Metallic System Components (Cu-alloys)

Task 2 has two main objectives. The first material-related objective is to document the degradation over time of Cu-containing alloys when immersed in the various blends and feedstocks of biodiesel. For this, one alloy will be utilized as a prudent example of common Cu-based alloys which experience regular incidence with the fuel. The second is to also monitor the oxidation of the fuel with respect to time of exposure to the alloy. Both experiments will take place in the same test cell. The type of cell pictured in Figure 2 allows for the insertion of counter and reference electrodes in order to monitor the corrosion behavior of the Cu-containing alloys electrochemically. Periodic samples of the fuel blend will also be collected to test for degradation of the biodiesel over the time period of the exposures. A series of eight additional test cells like pictured in Figure 1 will be allocated to electrochemical monitoring of the Cu-alloy corrosion behavior using a multiplexed potentiostat. These will also be temperature controlled using a circulating bath at 38 +/- 1^{o}C.

Task 3 – Integrity of Non-Metallic System Components (Elastomers)

For the testing of elastomer materials, a 28 test tube block furnace is used. Each test tube will hold contain one specific experiment in the matrix. The objective is to discern the tendency of specific elastomeric materials to swell, experience increased brittleness and have a reduction in compression strength as a result of prolonged exposure to the matrix of biodiesel blends.

Figure 4. "Medusa", the 28 vessel block oven used for elastomeric testing in fuel.

Unfortunately, the start of testing is still suspended pending the arrival of biodiesel samples. As of the preparation of this report, fuel samples from independent sources (not with the aide of the NBB) are to have been shipped. Testing should begin in the first couple of weeks of Q4.